

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of

SHANE ELWART, GOPICHANDRA SURNILLA and JOSEPH R. THEIS

Serial No. : 10/767,339 Group Art Unit: 1793  
Filed : January 28, 2004 Examiner: Edward M. Johnson  
For : SYSTEM AND METHOD FOR REMOVING HYDROGEN SULFIDE  
FROM AN EMISSIONS STREAM

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**I. REAL PARTY IN INTEREST**

The real party in interest is Ford Global Technologies, LLC.

## **II. RELATED APPEALS AND INTERFERENCES**

Applicants are not aware of any appeals or interferences that may be related to, or directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

### **III. STATUS OF CLAIMS**

All pending claims have been finally rejected. All pending claims are under appeal.

#### **IV. STATUS OF AMENDMENTS**

An amendment after final was filed on March 15, 2006. The amendment attempted to replace the term “based on” with “in response to” in various claims. The Examiner, however, did not enter the amendment stating that such would be a “new issue requiring further consideration and/or search [sic].”

Applicants have therefore presented arguments in this appeal assuming the claims are limited via the “based on” language as originally presented in the application.

## V. SUMMARY OF CLAIMED SUBJECT MATTER

As described in Applicants' specification, various mechanisms have been developed to reduce NOx emissions in lean-burning engines. One mechanism is a catalyst known as a NOx trap. While the use of a NOx trap can substantially reduce NOx emissions from a lean-burning engine, NOx traps are also susceptible to poisoning from sulfur in fuels, thus degrading performance. Specification, page 1, line 11 to page 2, line 2.

Therefore, to reinstate performance, various methods of desulfating NOx traps may be used. These methods, while effective in removing SOx from the trap surfaces, can cause the production of hydrogen sulfide. Specifically, the inventors herein have recognized that variations in air-fuel ratio that may occur at certain stages of reactions can cause the production of hydrogen sulfide in different ways depending on exhaust temperature. Specification, page 2, lines 3-7.

Thus, one approach to solve this problem is set forth in claim 1, which claims:

A method of removing hydrogen sulfide from an emissions stream, comprising:

directing the emissions stream into a hydrogen sulfide converter having a metal oxide catalyst (Specification, page 6, line 20 to page 7, lines 20, Figure 2, for example);

adsorbing the hydrogen sulfide in the emissions stream to the metal oxide catalyst in the hydrogen sulfide converter (Specification, page 7, line 9 – page 8, line 8, page 11, line 12- page 12, line 19, for example);

reacting the hydrogen sulfide with at least one of an oxidant and a reductant in the hydrogen sulfide converter to chemically transform the hydrogen sulfide (Specification, page 7, line 9 – page 8, line 8, page 11, line 12- page 12, line 19, for example); and

adjusting an air-fuel ratio of the emissions stream based on exhaust temperature of an emission control device, where said adjustment varies a duration of at least one of lean and rich operation to perform said adsorbing and reacting even as exhaust temperature varies (Specification, page 17, line 1-21, Figure 8, block 616, for example).



Specifically, by adjusting the air-fuel ratio of the emissions stream based on exhaust temperature of an emission control device (where the adjustment varies a duration of at least one of lean and rich operation to perform the adsorbing and reacting even as exhaust temperature varies), it is possible to reduce the emission of hydrogen sulfide across a wider temperature range. Specification, page 2, lines 10-20.

Another approach described in the application is set forth in claim 21, which claims:

21. A method of desulfating a catalytic converter, comprising:  
adjusting an exhaust air-fuel ratio entering said catalytic converter between rich and lean operation, where durations of said rich and lean operation are adjusted based on catalyst temperature to (Specification, page 17, line 1-21, Figure 8, block 616, for example):  
form hydrogen sulfide from sulfur in the catalytic converter (Specification, page 6, line 13 to page 7, line 2, for example);  
transport the hydrogen sulfide out of the catalytic converter and into a nickel oxide catalyst downstream of the catalytic converter (Specification, page 7, lines 3-8, Figure 2, for example);  
form nickel sulfide from the hydrogen sulfide in the nickel oxide catalyst (Specification, page 7, line 9 to page 8, line 15, Figures 2-4, for example); and  
form sulfur dioxide from the nickel sulfide in the nickel oxide catalyst (Specification, page 7, line 9 to page 8, line 15, Figures 2-4, for example).

Still another approach described in the application is set forth in claim 31, which claims:

31. In a mechanical apparatus having a combustion engine, a method of desulfating a catalytic converter, the method comprising:  
forming hydrogen sulfide from sulfur in the catalytic converter (Specification, page 6, line 13 to page 7, line 2, for example);  
transporting the hydrogen sulfide out of the catalytic converter and into a nickel oxide catalyst downstream of the catalytic converter (Specification, page 7, lines 3-8, Figure 2, for example);  
providing a rich air/fuel ratio to the combustion engine for a first interval to increase an amount of a reductant in an exhaust stream from the engine (Specification, Figures 2, 3, 4, page 6, line 20 et seq., for example); and  
providing a lean air/fuel ratio to the combustion engine for a second interval to increase an amount of an oxidant in the exhaust stream, wherein durations of said rich and lean air/fuel ratios are adjusted based on exhaust temperature of the converter (Specification, Figures 2, 3, 4, page 6, line 20 et seq., and page 17, line 1-21, Figure 8, block 616, and page 7, line 20 to page 8, line 8 for example).

Further, various additional features are included in dependent claims, which include:

5. The method of claim 3, further comprising reacting the nickel sulfide with an oxidant to form nickel sulfate (Specification, pages 7-8, reaction (2)).

8. The method of claim 5, wherein the nickel sulfide is reacted with the oxidant at a temperature of between approximately 625 and 675 degrees Celsius (Specification, page 9, lines 1-5, and original claim 8, for example)).

10. The method of claim 5, further comprising reacting the nickel sulfate with a reductant to produce sulfur dioxide and to regenerate the nickel oxide (Specification, pages 7-8, reaction (3), for example).

11. The method of claim 10, wherein the reductant is hydrogen gas (Specification, pages 7-8, reaction (3), for example).

13. The method of claim 3, wherein the nickel sulfide is reacted with the oxidant at a temperature of between 350 and 400 degrees Celsius (Specification, page 16, lines 1-8, for example).

19. The method of claim 18, wherein flowing varying amounts of a reductant and an oxidant over the nickel oxide catalyst includes first flowing hydrogen over the catalyst to reduce the hydrogen sulfide to nickel sulfide, then flowing at least one of oxygen and sulfur dioxide over the catalyst to convert the nickel sulfide to nickel sulfate, and then flowing hydrogen over the catalyst to convert the nickel sulfate to nickel oxide and sulfur dioxide (Specification, pages 7-8, reactions (1) to (3), for example).

**VI. GROUND OF REJECTION TO BE REVIEWED ON APPEAL**

The final Office action sets forth two grounds for rejection under 35 U.S.C. §103, each of which is to be reviewed on appeal.

- A)                    2.    Claims 1-3, 5-7, 10, 12, 16-18, 21, 24-27, 29, 31-33, and  
                         36-40 are rejected under 35 U.S.C. 103(a) as being unpatentable  
                         over Bartley et al. US 6,482,377.
- B)                    3.    Claims 4, 8-9, 11, 13-15, 19-20, 22-23, 28, 30, and 34-35,  
                         are rejected under 35 U.S.C. 103(a) as being unpatentable over  
                         Bartley '377 as applied to claims 1, 16, 21, and 31, above, and  
                         further in view of Li US 6,419,890.

## VII. ARGUMENT

### **A. Rejection of Claims 1-3, 5-7, 10, 12, 16-18, 21, 24-27, 29, 31-33, and 36-40 Under 35 U.S.C. §103(a) as Being Unpatentable Over Bartley et al. (US Patent No. 6,482,377) Should Be Reversed**

1. *Claims 1-3, 5-7, 10, 12, 16-18, 21, 24-27, 29, 31-33, and 36-40 are not properly rejected via Bartley et al. because even with the suggested modification Bartley et al. fails to disclose all claim elements and there is no evidence of record to support the suggested modifications.*

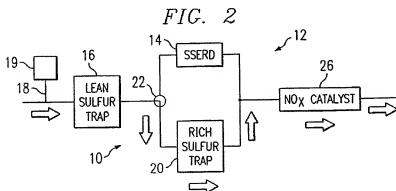
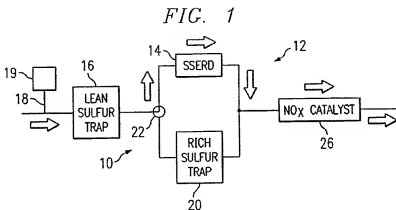
#### *a. Introduction.*

As noted in The Summary of Claimed Subject Matter, the approach of claim 1 solves various issues related to desulfating an emission control device, such as a NO<sub>x</sub> trap. Specifically, by adjusting the air-fuel ratio of the emissions stream based on exhaust temperature of an emission control device (where the adjustment varies a duration of at least one of lean and rich operation to perform adsorbing and reacting even as exhaust temperature varies), it is possible to reduce the emission of hydrogen sulfide across a wider temperature range. For example, different reactions in the exhaust can occur at different temperatures, and thus different durations of lean and/or rich operation may be provided to perform desired adsorbing and reacting. Thus, by adjusting the air-fuel ratio based on exhaust temperature, where the adjustment includes varying a duration of at least one of the lean and rich operation, it is possible to perform the adsorbing and reacting even as exhaust temperature varies.

#### *b. The primary reference, Bartley et al.*

Bartley et al. relates to a method of treating exhaust using two sulfur traps (16, 20) as shown in the reproduced figures below. The method first directs exhaust to the first sulfur trap, which treats the exhaust and discharges exhaust that is allegedly substantially free of sulfur (Figure 1). Then, when the first trap (16) is saturated with sulfates, the exhaust is diverted to the

second sulfur trap (20) (Figure 2). During this diversion, a reducing agent introduced upstream of the first sulfur trap aids in purging the first sulfur trap and in reducing metal sulfates and metal sulfites in the first sulfur trap to hydrogen sulfides, which are then treated by the second sulfur trap. When the first sulfur trap is purged, the exhaust gas is again directed as shown in Figure 1.



The detailed reactions that occur during the above processes are described in depth at Figure 3 and the corresponding text of the specification. Specifically, Figure 3 illustrates how the various reactions take place in the various locations at different conditions.

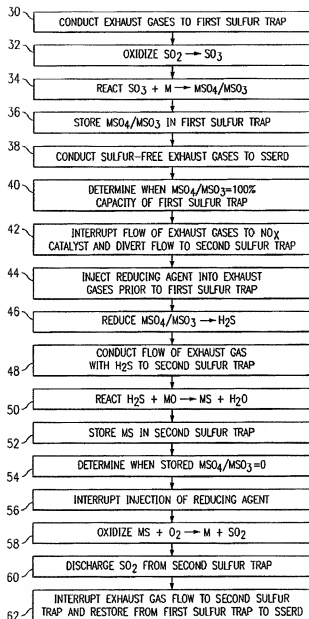


FIG. 3

*c. The Reasoning of the rejection.*

The standing rejection relies on Bartley et al. under 35 U.S.C. §103, and states:

Regarding claims 1, 16, 21, and 31, Bartley '377 discloses a method for removing sulfur from an exhaust stream comprising directing the exhaust to a sulfur trap comprising metal oxide, adsorbing hydrogen sulfide (see column 5, lines 56-63) and reacting with a reducing agent (abstract).

However, it is expressly admitted by the Office action that:

Bartley '377 fails to disclose adjusting an air-fuel ratio based on exhaust temperature.

Finally, the Office action goes on to state:

It would have been obvious to one of ordinary skill in the art at the time the invention was made to adjust the air-fuel ratio to either rich or lean in the method of Bartley because Bartley discloses operation of the method for both lean and rich stoichiometries (see column 5, lines 44-46 and 56-58), which would obviously, to one of ordinary skill, suggest adjustment of the ratio to perform the method at the disclosed rich and lean stages.

The standing rejection, however, contains nothing regarding how the temperature-based air-fuel ratio adjustment varies a duration of at least one of lean and rich operation to perform the adsorbing (of hydrogen sulfide to a metal oxide), and reacting (of the hydrogen sulfide with at least one of an oxidant and a reductant to transform the hydrogen sulfide). In fact, the standing rejection does not even contain an allegation that such features are shown in any cited reference.

Further, it does not contain any allegation that such features would be obvious based on evidence of record.

*d. The Office action fails to even allege that all claimed elements are shown or suggested in the cited reference.*

First, it has to be stressed that the Examiner admits Bartley et al. fails to show adjusting an air-fuel ratio based on exhaust temperature.

Second, even assuming Bartley et al. suggest adjustment of air-fuel ratio to perform the method at lean and rich stages, and even assuming it would be obvious to adjust the air-fuel ratio to either rich or lean in the Bartley et al. method, claimed elements are still missing. Specifically, the Office action fails to allege that Bartley et al. show or suggest a temperature-based air-fuel ratio adjustment that varies a duration of at least one of lean and rich operation to perform the adsorbing and reacting even as exhaust temperature varies. Rather, the Office action simply rips the entire last phrase out of claim 1, along with its relationship to other claim elements, which is depicted pictorially below:

1. (original) A method of removing hydrogen sulfide from an emissions stream, comprising:  
directing the emissions stream into a hydrogen sulfide converter having a metal oxide catalyst;  
adsorbing the hydrogen sulfide in the emissions stream to the metal oxide catalyst in the hydrogen sulfide converter;  
reacting the hydrogen sulfide with at least one of an oxidant and a reductant in the hydrogen sulfide converter to chemically transform the hydrogen sulfide; and  
adjusting an air-fuel ratio of the emissions stream based on exhaust temperature of an emission control device,

where said adjustment varies a duration of at least one of lean and rich operation to perform said adsorbing and reacting even as exhaust temperature varies.



Thus, taking everything stated in the standing rejection as true,<sup>1</sup> the rejection is defective on its face as it completely fails to address specific claimed elements. For this reason alone, the rejection should be reversed.

*e. The Office action reasoning in support of obviousness misses the point.*

As noted above, the Office action supports the obviousness of missing claimed elements on the theory that:

It would have been obvious to one of ordinary skill in the art at the time the invention was made to adjust the air-fuel ratio to either rich or lean in the method of Bartley because Bartley discloses operation of the method for both lean and rich stoichiometries (see column 5, lines 44-46 and 56-58), which would obviously, to one of ordinary skill, suggest adjustment of the ratio to perform the method at the disclosed rich and lean stages.

Upon close inspection, the above reasoning appears to state: because Bartley et al. allegedly discloses lean and rich operation, such disclosure suggests adjustment of lean and rich operation. Applicants respectfully submit that whether or not the reference suggests adjustment of lean or rich operation misses the point. *I.e.*, this says nothing about whether adjustment of air-fuel ratio based on exhaust temperature would be suggested by the cited reference. In other words, it is the admittedly missing feature (adjustment of air-fuel ratio based on temperature) that must be shown or suggested, not merely a portion of the missing feature.

Furthermore, as the cited reference admittedly does not have any disclosure of adjustments based on temperature, Applicants respectfully submit that it is improper to conclude

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<sup>1</sup> It should be clear that Applicants do not admit that everything in the standing rejection is true.

that the claimed adjustment of air-fuel ratio of the emissions stream (based on exhaust temperature of an emission control device, where the adjustment varies a duration of at least one of lean and rich operation to perform the adsorbing and reacting even as exhaust temperature varies) is obvious. To be sure, the Office action fails to cite any disclosure or suggestion in Bartley et al. relating to adjusting anything based on temperature.

Furthermore, Applicants have reviewed Bartley et al. and find the term "temperature" mentioned only twice in the document. The first is at Col. 1, lines 26-28, and gives no indication of adjusting durations of lean or rich operation based on temperature:

Internal combustion engines generate oxides of nitrogen (NOx) emissions as the result of high temperature combustion.

The second mention is at Col. 4, lines 25-33, and again has nothing to do with adjusting durations of lean or rich operation:

The sulfur trap system 10 embodying the present invention includes a first sulfur trap 16 disposed to receive exhaust gases discharged from an internal combustion engine (not shown), then discharge the exhaust gases to a bypass or diverter valve 22, preferably formed of a high-temperature, corrosion-resistant metal, for subsequent selective distribution to either the sulfur-sensitive emission reduction device (SSERD) 14 as illustrated in FIG. 1, or to a second sulfur trap 20 as shown in FIG. 2.

Applicants respectfully submit that the Office action has thus fallen victim to the attraction of hindsight, and used that which only Applicants teach against its teacher. Again, for this reason alone, the rejection of claim 1 should be reversed.

*f. The cited art suffers from precisely the disadvantages the present application aims to address.*

Applicants respectfully submit that not only has the Office action failed to establish a *prima facie* case of obviousness, but that the evidence of record actually supports the opposite conclusion. Specifically, Bartley et al. suffers from precisely the same disadvantages as those noted in Applicants' specification. *I.e.*, because Bartley et al. does not adjust air-fuel ratio based on temperature, there can be no compensation of the lean and rich operation to perform the adsorbing and reacting of hydrogen sulfide even as exhaust temperature varies in a way that results in reduced emissions of hydrogen sulfide. Further, Bartley et al. gives absolutely no hint of how to perform any adjustment of air-fuel ratio to compensate for temperature variation, or even that variation in exhaust temperature can affect the reactions in the emission control device.

Unlike the cited art, the approach of claim 1 adjusts an air-fuel ratio of the emissions stream based on exhaust temperature of an emission control device, where said adjustment varies a duration of at least one of lean and rich operation to perform the adsorbing and reacting even as exhaust temperature varies. By adjusting the duration of the lean and/or rich operation of the adsorbing and reacting in this way, it is possible to perform various selected reactions to reduce the emission of hydrogen sulfide across a wider temperature range.

Applicants respectfully submit that adding such features to the method of Bartley et al. would hardly be obvious based on the evidence of record.

Regarding the adjustment of air-fuel ratio based on temperature, the above arguments also apply to independent claims 16, 21, and 31, as well as all claims depending therefrom.

- 2. Claims 5, 10, 21, and 31 are not properly rejected via Bartley et al. for the reasons discussed above and because Bartley et al. fails to disclose additional elements recited in these claims.*

*a. Claim 5.*

One element of the method of claim 1 includes reacting hydrogen sulfide with at least one of an oxidant and a reductant in the hydrogen sulfide converter to chemically transform the hydrogen sulfide. Claim 5, which includes the limitations of claim 3, specifies that the hydrogen sulfide is reacted with the reductant to form nickel sulfide, and the method further includes reacting nickel sulfide with an oxidant to form nickel sulfate. Further, claim 3 depends from claim 2, which states the metal oxide catalyst includes nickel oxide.

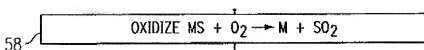
One example embodiment of various of these reactions is described at pages 7-8 of the application, and specifically reaction (2) illustrates the formation of nickel sulfate.

Turning now to the rejection, the Office action states that:

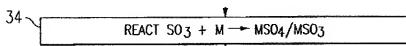
Regarding claims 3, 5, 25-26, 29, and 32-33 Bartley '377  
discloses forming the metal sulfide (see column 5, line 61) and  
sulfate (see column 6, lines 20-23).

However, upon reviewing Col. 5, line 61 and Col. 6, lines 20-23, Applicants find nothing that shows reacting a nickel sulfide with an oxidant to form nickel sulfate (where the nickel sulfide is formed from a reaction of hydrogen sulfide with a reductant in a converter having a nickel oxide catalyst). In other words, Applicants can find nothing that shows forming a nickel sulfate by reacting a nickel sulfide with an oxidant (where the nickel sulfide is formed from a reaction of hydrogen sulfide with a reductant in a converter having a nickel oxide catalyst).

Rather, Bartley et al. shows both sulfides and sulfates in a different context. Specifically, Bartley et al. shows reacting a metal sulfide (MS) with oxygen (O<sub>2</sub>), where sulfur dioxide is formed, not a sulfate, as shown clearly in block 58, reproduced below:



Likewise, Bartley et al. shows reacting sulfur trioxide with an elemental metal (not a metal oxide) to form a sulfate (MSO<sub>4</sub>), as shown clearly in block 34, also reproduced below:



In other words, Bartley et al. discloses the reaction of metal sulfide with oxygen to form sulfur dioxide, not a sulfate. Further, Bartley discloses the formation of metal sulfate in the presence of an elemental metal catalyst, not a metal oxide catalyst. Finally, Bartley describes the metal sulfate as a product of the reaction between sulfur trioxide and the elemental metal, not a sulfide.

Thus, the Office action appears to be referring to the mere mention of “sulfides” and “sulfates,” without any regard to the actual disclosure of the reference, and without regard to the actual claim limitations. As such, from the actual disclosure of the reference, Applicants respectfully submit that the rejection of claim 5 should be reversed for this additional reason since there is no disclosure of reacting the nickel sulfide with an oxidant to form nickel sulfate.

*b. Claim 10.*

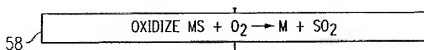
Claim 10, which depends from claim 5, further specifies that the method includes reacting the nickel sulfate with a reductant to produce sulfur dioxide and to regenerate the nickel oxide.

In rejecting the claim, the Office action states:

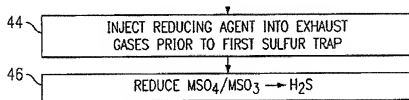
Regarding claims 2, 10, 12, and 17-18, Bartley '377 discloses sulfur dioxide (see paragraph bridging columns 5-6) and nickel oxide (see column 5, lines 56-59).

However, upon reviewing the cited disclosure, Applicants find nothing that shows reacting the nickel sulfate with a reductant to produce sulfur dioxide to regenerate the nickel oxide.

Rather, Bartley et al. shows reacting nickel sulfate with oxygen, not a reductant to produce sulfur dioxide (see step 58 of Figure 3):



Further, Bartley et al. shows reducing metal sulfate with the reductant to form hydrogen sulfide, not sulfur dioxide, and not to regenerate nickel oxide (see steps 44 and 46 of Figure 3):



As such, upon a careful reading of the actual disclosure of the reference, Applicants respectfully submit that the rejection of claim 10 should be reversed as the cited disclosure fails to show that which is claimed.

*c. Claim 21.*

The Office action provides no specific rejection of claim 21, but rather addresses claim 21 along with Claim 1. Thus, for the reasons set forth above, the rejection of claim 21 should also be reversed.

However, there are additional reasons for the reversal of the rejection of Claim 21, which is reproduced below for ease in reading. It states:

21. (original) A method of desulfating a catalytic converter, comprising:

adjusting an exhaust air-fuel ratio entering said catalytic converter between rich and lean operation, where durations of said rich and lean operation are adjusted based on catalyst temperature to:

- form hydrogen sulfide from sulfur in the catalytic converter;
- transport the hydrogen sulfide out of the catalytic converter and into a nickel oxide catalyst downstream of the catalytic converter;
- form nickel sulfide from the hydrogen sulfide in the nickel oxide catalyst;
- and
- form sulfur dioxide from the nickel sulfide in the nickel oxide catalyst.

Applicants can find nothing in Bartley et al. that shows adjusting an exhaust air-fuel ratio entering said catalytic converter between rich and lean operation, where durations of said rich and lean operation are adjusted based on catalyst temperature to perform the specified chemical formations and transportation.

Further, Applicants respectfully submit that the standing rejection fails to provide sufficient evidence of record to support the assertion that such missing elements are obvious.

*d. Claim 31.*

The Office action provides no specific rejection of claim 31, but rather addresses claim 31 along with Claim 1. Thus, for the reasons already set forth above, the rejection of claim 31 should also be reversed.

However, there are additional reasons for the reversal of the rejection of Claim 31, which is reproduced below for ease in reading. It states:

31. (original) In a mechanical apparatus having a combustion engine, a method of desulfating a catalytic converter, the method comprising:  
forming hydrogen sulfide from sulfur in the catalytic converter;  
transporting the hydrogen sulfide out of the catalytic converter and into a nickel oxide catalyst downstream of the catalytic converter;  
providing a rich air/fuel ratio to the combustion engine for a first interval to increase an amount of a reductant in an exhaust stream from the engine; and

providing a lean air/fuel ratio to the combustion engine for a second interval to increase an amount of an oxidant in the exhaust stream, wherein durations of said rich and lean air/fuel ratios are adjusted based on exhaust temperature of the converter.

Applicants can find nothing in Bartley et al. that shows providing a rich air/fuel ratio to the combustion engine for a first interval to increase an amount of a reductant in an exhaust stream from the engine; and providing a lean air/fuel ratio to the combustion engine for a second interval to increase an amount of an oxidant in the exhaust stream, wherein durations of said rich and lean air/fuel ratios are adjusted based on exhaust temperature of the converter.

Further, Applicants respectfully submit that the standing rejection fails to provide sufficient evidence of record to support the assertion that such missing elements are obvious.

**B. Rejection of Claims 4, 8-9, 11, 13-15, 19-20, 22-23, 28, 30, and 34-35 Under 35 U.S.C. §103(a) as Being Unpatentable Over Bartley et al. in View of Li (US Patent No. 6,419,890) Should Be Reversed**

- 1. Claims 4, 8-9, 11, 13-15, 19-20, 22-23, 28, 30, and 34-35 are not properly rejected via Bartley et al. and Li because even when combined and modified as suggested Bartley et al. and Li fail to disclose all claim elements.*

As described in detail above, the standing rejections of independent claims 1, 16, 21, and 31 should be withdrawn because Bartley et al. fails to disclose each and every element recited in those claims. Li does not cure the above described deficiencies of Bartley et al. As an example, Li does not disclose adjusting an air fuel ratio based on exhaust temperature, as claimed. As another example, Li does not disclose a temperature-based air-fuel ratio adjustment that varies a duration of at least one of lean and rich operation to perform the adsorbing and reacting even as exhaust temperature varies, as claimed. Accordingly, rejection of dependent claims 4, 8-9, 11,



13-15, 19-20, 22-23, 28, 30, and 34-35 should be withdrawn for at least the reasons discussed above.

2. *Claims 8, 9, 11, 13, 19, and 28 are not properly rejected via Bartley et al. and Li for the reasons discussed above and because Bartley et al. and Li fail to collectively disclose additional elements recited in these claims.*

a. *Claim 8.*

Claim 8, which depends from claim 5, further specifies that the nickel sulfide is reacted with the oxidant at a temperature of between approximately 625 and 675 degrees Celsius. The Office action relies on Li as showing lean/rich operation at 625-750 C. However, upon reviewing Col. 12, lines 21-26, Applicants find nothing that shows the oxidation of nickel sulfide approximately between 625 and 675 degrees Celsius. Rather, Li et al. explains the preparation of anionic clay materials.

As such, upon a careful reading of the actual disclosure of the reference, Applicants respectfully submit that the rejection of claim 8 should be reversed.

b. *Claim 9.*

Claim 9, which depends from claim 5, further specifies that the nickel sulfide is reacted with the oxidant at a temperature of between approximately 575 and 625 degrees Celsius. Again, as noted above, the basis for the rejection appears unfounded.

c. *Claim 11.*

Claim 11, which includes the limitations of claim 10, further specifies that the reductant reacting with the nickel sulfate to form sulfur dioxide and to regenerate the nickel oxide is hydrogen gas. The Office action again relies on Li to show hydrogen gas. However, even assuming Li shows hydrogen gas, this says nothing about whether Li shows using it as a reductant to react with nickel sulfate to form sulfur dioxide. Thus, upon reviewing Col. 8, lines

49-50, Applicants find nothing that shows the reducing agent of the reaction of nickel sulfate to form sulfur dioxide to be hydrogen.

*d. Claim 13.*

Claim 13, which depends from claim 3, further specifies that the nickel sulfide is reacted with the oxidant at a temperature of between 350 and 400 degrees Celsius. The Office action references Figure 1 of Li as showing the temperature range, however, Figure 1 relates to NOx reaction, not the reactions specified in claim 13. As such, the rejection should be reversed.

*e. Claim 19.*

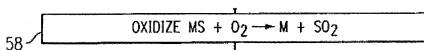
Claim 19 includes the limitations of claims 18, 17, and 16. Claim 19 is reproduced below for ease of reading.

19. The method of claim 18, wherein flowing varying amounts of a reductant and an oxidant over the nickel oxide catalyst includes first flowing hydrogen over the catalyst to reduce the hydrogen sulfide to nickel sulfide, then flowing at least one of oxygen and sulfur dioxide over the catalyst to convert the nickel sulfide to nickel sulfate, and then flowing hydrogen over the catalyst to convert the nickel sulfate to nickel oxide and sulfur dioxide.

The Office action relies primarily on Bartley et al., except for the disclosure of hydrogen gas, which is allegedly shown by Li. However, Applicants respectfully submit that the Office action fails to consider explicit claim elements. In particular, Applicants respectfully submit that the Office actions fails to even allege any of the elements of claim 19 are shown in any reference.

For example, claim 19 specifies an order of three operations that are part of the flowing of varying amount of a reductant and an oxidant over the nickel oxide catalyst. The method includes flowing hydrogen over the catalyst to reduce the hydrogen sulfide to nickel sulfide, then

flowing at least one of oxygen and sulfur dioxide over the catalyst to convert the nickel sulfide to nickel sulfate, and then flowing hydrogen over the catalyst to convert the nickel sulfate to nickel oxide and sulfur dioxide. As just an example, Applicants can find nothing in Bartley et al. that shows flowing a reductant over the catalyst to convert the nickel sulfate to nickel oxide and sulfur dioxide. Rather, step 58 of Bartley et al., reproduced below, shows reacting the metal sulfide with oxygen, not a reductant, to form sulfur dioxide.



Thus, the rejection of claim 19, like the rejection of many claims in the Office action, should be reversed merely on the grounds that the record fails to contain any allegation that all elements of the claim are shown or suggested. Further, it should be reversed because the actual disclosure of the reference fails to show claimed elements.

*f. Claim 28.*

Claim 28 depends from claim 26, which depends from claim 25, which depends from claim 21. Applicants have reviewed the cited disclosure and fail to find the specified reactions as set forth. Further, as noted above, Applicants fail to find any disclosure of performing the specified reactions at the specified temperature. The cited disclosure in the Office action is simply not relevant. As such, the rejection should be reversed.

**C. Conclusion and request for relief**

As described in detail above, the standing rejections are inadequate for numerous reasons. Applicants therefore respectfully request that the Board reverse the standing rejections of the

Final rejection, and direct the Examiner to allow all pending claims, or any allowable subset thereof.

## VIII. CLAIMS APPENDIX

1. (original) A method of removing hydrogen sulfide from an emissions stream, comprising:  
directing the emissions stream into a hydrogen sulfide converter having a metal oxide catalyst;  
adsorbing the hydrogen sulfide in the emissions stream to the metal oxide catalyst in the hydrogen sulfide converter;  
reacting the hydrogen sulfide with at least one of an oxidant and a reductant in the hydrogen sulfide converter to chemically transform the hydrogen sulfide; and  
adjusting an air-fuel ratio of the emissions stream based on exhaust temperature of an emission control device, where said adjustment varies a duration of at least one of lean and rich operation to perform said adsorbing and reacting even as exhaust temperature varies.
2. (original) The method of claim 1, wherein the metal oxide catalyst includes nickel oxide.
3. (original) The method of claim 2, wherein the hydrogen sulfide is reacted with the reductant to form nickel sulfide.
4. (original) The method of claim 3, wherein the reductant is hydrogen gas.
5. (original) The method of claim 3, further comprising reacting the nickel sulfide with an oxidant to form nickel sulfate.

6. (original) The method of claim 5, wherein the oxidant includes at least one substance selected from the group consisting of oxygen and sulfur dioxide.
7. (original) The method of claim 5, wherein the oxidant is produced by a combustion engine running a lean air/fuel mixture.
8. (original) The method of claim 5, wherein the nickel sulfide is reacted with the oxidant at a temperature of between approximately 625 and 675 degrees Celsius.
9. (original) The method of claim 5, wherein the nickel sulfide is reacted with the oxidant at a temperature of between approximately 575 and 625 degrees Celsius.
10. (original) The method of claim 5, further comprising reacting the nickel sulfate with a reductant to produce sulfur dioxide and to regenerate the nickel oxide.
11. (original) The method of claim 10, wherein the reductant is hydrogen gas.
12. (original) The method of claim 3, further comprising reacting the nickel sulfide with oxygen to directly form nickel oxide and sulfur dioxide.
13. (original) The method of claim 3, wherein the nickel sulfide is reacted with the oxidant at a temperature of between 350 and 400 degrees Celsius.

14. (original) The method of claim 1, wherein the reductant is hydrogen gas.
15. (original) The method of claim 14, wherein the hydrogen gas is produced by a combustion engine running a rich air/fuel mixture.
16. (original) A method of desulfating a catalytic converter, comprising:  
transforming sulfur in the catalytic converter to hydrogen sulfide;  
transporting the hydrogen sulfide out of the catalytic converter;  
adsorbing the hydrogen sulfide to a nickel oxide catalyst; and  
flowing varying amounts of a reductant and an oxidant over the nickel oxide catalyst to chemically transform the hydrogen sulfide into at least one other gas-phase sulfur compound, wherein said varying amounts are selected based on exhaust temperature of the catalytic converter, where said selection varies a duration of exposure of said reductant to perform said transforming even as exhaust temperature varies.
17. (original) The method of claim 16, wherein the at least one other gas-phase sulfur compound is sulfur dioxide.
18. (original) The method of claim 17, wherein the hydrogen sulfide is converted to sulfur dioxide via an intermediate nickel sulfide compound.
19. (original) The method of claim 18, wherein flowing varying amounts of a reductant and an oxidant over the nickel oxide catalyst includes first flowing hydrogen over the catalyst to

reduce the hydrogen sulfide to nickel sulfide, then flowing at least one of oxygen and sulfur dioxide over the catalyst to convert the nickel sulfide to nickel sulfate, and then flowing hydrogen over the catalyst to convert the nickel sulfate to nickel oxide and sulfur dioxide.

20. (original) The method of claim 17, wherein flowing varying amounts of a reductant and an oxidant over the nickel oxide catalyst includes first flowing hydrogen over the catalyst to reduce the hydrogen sulfide to nickel sulfide, then flowing oxygen over the catalyst to directly convert the nickel sulfide to sulfur dioxide.

21. (original) A method of desulfating a catalytic converter, comprising:

adjusting an exhaust air-fuel ratio entering said catalytic converter between rich and lean operation, where durations of said rich and lean operation are adjusted based on catalyst temperature to:

form hydrogen sulfide from sulfur in the catalytic converter;

transport the hydrogen sulfide out of the catalytic converter and into a nickel oxide catalyst downstream of the catalytic converter;

form nickel sulfide from the hydrogen sulfide in the nickel oxide catalyst; and

form sulfur dioxide from the nickel sulfide in the nickel oxide catalyst.

22. (original) The method of claim 21, wherein forming nickel sulfide from the hydrogen sulfide includes reacting the hydrogen sulfide with hydrogen gas on the nickel oxide catalyst.



23. (original) The method of claim 21; wherein the hydrogen sulfide is reacted with hydrogen gas at a temperature of between approximately 625 and 675 degrees Celsius.
24. (original) The method of claim 21, wherein the hydrogen gas is produced by a combustion engine running a rich air/fuel mixture.
25. (original) The method of claim 21, wherein forming sulfur dioxide from the nickel sulfide includes forming nickel sulfate from the nickel sulfide, and then forming sulfur dioxide from the nickel sulfate.
26. (original) The method of claim 25, wherein the nickel sulfate is formed by reacting the nickel sulfide with oxygen and sulfur dioxide, and wherein the sulfur dioxide is formed by reacting the nickel sulfate with hydrogen.
27. (original) The method of claim 26, wherein the hydrogen is produced by a combustion engine running a rich air/fuel mixture.
28. (original) The method of claim 26, wherein the nickel sulfide is reacted with oxygen and sulfur dioxide at a temperature of approximately 600 degrees Celsius, and wherein the nickel sulfate is reacted with hydrogen at a temperature of approximately 650 degrees Celsius.
29. (original) The method of claim 21, wherein forming sulfur dioxide from the nickel sulfate includes reacting the nickel sulfide with oxygen to form sulfur dioxide directly.

30. (original) The method of claim 29, wherein the nickel sulfide is reacted with the oxygen at a temperature of between 350 and 400 degrees Celsius.

31. (original) In a mechanical apparatus having a combustion engine, a method of desulfating a catalytic converter, the method comprising:

forming hydrogen sulfide from sulfur in the catalytic converter;

transporting the hydrogen sulfide out of the catalytic converter and into a nickel oxide catalyst downstream of the catalytic converter;

providing a rich air/fuel ratio to the combustion engine for a first interval to increase an amount of a reductant in an exhaust stream from the engine; and

providing a lean air/fuel ratio to the combustion engine for a second interval to increase an amount of an oxidant in the exhaust stream, wherein durations of said rich and lean air/fuel ratios are adjusted based on exhaust temperature of the converter.

32. (original) The method of claim 31, wherein the reductant is hydrogen and reacts with the hydrogen sulfide on the nickel oxide catalyst to form nickel sulfide.

33. (original) The method of claim 32, wherein the oxidant is oxygen and reacts with the nickel sulfide to form at least one of nickel sulfate and sulfur dioxide.

34. (original) The method of claim 33, wherein the oxidant reacts with the nickel sulfide to form nickel sulfate, further comprising reacting the nickel sulfate with hydrogen to form sulfur dioxide.

35. (original) The method of claim 34, wherein the hydrogen is formed by providing a rich air/fuel ratio to the combustion engine.

36. (original) The method of claim 31, further comprising providing a rich air/fuel ratio to the combustion engine for a third interval.

37. (original) The method of claim 31, wherein at least one of the first interval and second interval is defined by a fixed period of time.

38. (original) The method of claim 31, wherein at least one of the first interval and second interval is defined by a number of engine cycles.

39. (original) The method of claim 31, wherein the first interval is defined by a saturation point of hydrogen sulfide on the nickel oxide catalyst.

40. (original) The method of claim 31, wherein the second interval is defined by a saturation point of an oxidant on a nickel sulfide intermediate.

41-46. (cancelled).

**IX. EVIDENCE APPENDIX**

None.

**X. RELATED APPEAL APPENDIX**

None.